

# IRON OXIDE PIGMENTS

By Michael J. Potter

**Domestic survey data were prepared by Benjamin S. Goff, statistical assistant, and the world production table was prepared by Regina R. Coleman, international data coordinator.**

In 2004, total iron oxide pigment (IOP) production, using partly estimated data, decreased by 6% to 85,000 metric tons (t) valued at \$77 million. Exports of IOPs decreased by 31% to 3,120 t valued at about \$7.4 million. IOP imports increased by 21% to 170,000 t with China being the leading supplier.

Natural iron oxides are derived from hematite, which is a red iron oxide mineral; limonites, which vary from yellow to brown, such as ochers, siennas, and umbers; and magnetite, which is black iron oxide. Synthetic iron oxide pigments are produced from basic chemicals. The three major methods for the manufacture of synthetic iron oxides are thermal decomposition of iron salts or iron compounds; precipitation of iron salts, usually accompanied by oxidation; and reduction of organic compounds by iron (Podolsky and Keller, 1994, p. 765, 772).

## Production

U.S. production data for crude (natural) IOPs sold or used in 2004 were developed by the U.S. Geological Survey (USGS) from a voluntary survey of four companies, of which three responded (table 1). Data are withheld to avoid disclosing company proprietary data. In a second voluntary survey, data were received from 8 of 12 known processing operations (67%) for finished (natural and synthetic) IOPs (table 2). By tonnage, the 8 operations represented 53% of the output. Data for nonrespondents were estimated on the basis of prior-year levels of output.

At least three U.S. companies produced regenerated iron oxide, which is obtained when spent pickle liquor from steelmaking is treated (table 3). Data were obtained from one company. Regenerator iron oxide data were not included in tables 1, 2, and 4. A major end use for this material was ferrites, which are magnetic ceramic oxides. There are two types of ferrites—soft, which do not retain permanent magnetism, and hard, which retain permanent magnetism. Uses of soft ferrites include computers, cores for radio frequency coils, inverter cores, memory cores, microwave communication systems, microwave ferrites for telecommunications, pot cores, rectangular modulus cores, television deflection yokes, and other industrial applications (Govila, 1991, p. 2-3). Hard ferrites are used in flexible magnets, generators, loudspeakers, and motors.

Bayer AG formed a new company, Lanxess AG, by combining most areas of its chemicals business, including IOPs, and large parts of its polymer activities. Lanxess AG was scheduled to be listed on the Frankfurt Stock Exchange at the beginning of 2005 (Bayer Corp., 2004§<sup>1</sup>).

New Riverside Ochre Co., Cartersville, GA, was planning to introduce a new product, which will be a high-purity, micron-sized natural IOP. This micronized product will be directed toward the paint, paper, and plastic markets (O'Driscoll, 2004).

Rockwood Pigments NA, Inc. (a subsidiary of Rockwood Specialties Group, Inc.) acquired the business and assets of Hamburger Color Co. along with its plant and equipment in King of Prussia, PA. Hamburger has been an innovator in coloring concrete for more than 30 years, including the development of liquid IOP color suspensions and technologies to enhance concrete appearance (Rockwood Specialties Group, Inc, 2004a§).

## Consumption

Because of a low response rate, no 2004 U.S. data are included in IOP consumption, by end use (table 4). Typically, construction materials and paints and coatings have been the leading end uses of IOPs.

Construction applications included such concrete products as block, brick or segmental retaining wall units, mortar, paving stones, precast products of various sizes or dimensions, ready-mixed concrete, and roofing tiles (Bayer Corp., 2002§). Shipments of total paint and coatings, comprising architectural coatings, original equipment manufacture product coatings, and special-purpose coatings, increased by about 1% in 2004 compared with those of 2003 (U.S. Census Bureau, 2005§).

## Prices

In January, Rockwood Pigments raised prices worldwide for its iron oxide and natural color pigments. Reasons cited for the increase were the increase in costs of raw materials, such as scrap steel, natural gas and other energy-related costs, and ocean transportation (O'Driscoll, 2004).

Yearend 2004 IOP published prices, which are meant to serve as a general guideline only, converted from dollars per pound, in bags, per truckload, free on board warehouse, were black, synthetic, \$2.07 per kilogram; buff, natural, domestic, which included dark and light, \$1.16 to \$2.14 per kilogram; and yellow, synthetic, \$2.25 to \$2.34 per kilogram (Chemical Market Reporter, 2004). The average annual producer price index (PPI) for IOPs for 2004 was 180.2 compared with 178.1 in 2003. The PPI measures the average

<sup>1</sup>References that include a section mark (§) are found in the Internet References Cited section.

change over time in the selling prices received by domestic producers of IOPs. The base year for the IOP PPI is June 1983 (U.S. Bureau of Labor Statistics, 2005§).

## Foreign Trade

U.S. exports of pigment-grade IOPs in 2004 totaled 3,120 t, 31% less than those of 2003 (table 5). U.S. imports of IOPs of 170,000 t in 2004 were 21% higher than those of 2003 (table 6). By tonnage, the three leading sources were China with 57%; Germany, 26%; and Italy, 4% (table 7).

## World Review

Although production data have not been obtained by the USGS, Italy reportedly produces natural iron oxide, with cement being the leading market. Likewise, in Spain, most of the output is sold to cement producers. In Norway, Rana Gruber AS mines and refines magnetite and hematite. A subsidiary company, Rana Mineral AS, produces special products and has custom grinding. Most of Rana's products are sold as colorant for construction materials, paint, plastics, and rubber (O'Driscoll, 2004).

In Western Europe, the leading market segment for IOPs is said to be construction. Other end uses include paints and coatings, plastics, and paper. Although IOPs traditionally have been marketed in basic powder form, an increasing number of manufacturers are now also offering higher value-added granular or micronized grades. Some advantages of micronized grades compared with standard grades are said to be higher tinting strength, lower oil absorption, and easier dispersion (Will, Schlag, and Kishi, 2004, p. 575.0003O, 575.0003Y–575.0003Z).

Rockwood Specialties Group, Inc.'s subsidiary Rockwood Pigments (UK) Ltd. completed the acquisition of the pigments and dispersions business of Johnson Matthey PLC for about \$50 million. This acquisition comprises the production of transparent IOPs, color concentrates, and complex inorganic color pigments servicing the wood coatings, plastics, building materials, and printing inks markets. Included are manufacturing facilities in Kidsgrove and Sudbury, United Kingdom, and Braeside, Victoria, Australia (Rockwood Specialties Group, Inc., 2004b§).

Some price data, converted from euros per metric ton, were for natural IOPs, ex-works, about \$232 to \$378 per metric ton; for high-quality, high-lamellar content micaceous iron oxide (MIO) from Austria, free on board, about \$732 to \$976 per ton; and for milled MIO, ex-works Europe, about \$549 to \$732 per ton (O'Driscoll, 2004).

**Austria.**—Kärntner Montanindustrie GmbH (KMI) continued to be the world's leading producer of MIO. Output was about 5,000 t in 2004, with about 80% going into the anticorrosion coatings market. In early 2004, KMI began small-volume production of micronized MIO grades using proprietary technology. The material will be for the anticorrosion and other market sectors. The company also developed a cubical iron oxide for the paint and varnish markets (O'Driscoll, 2004).

## Outlook

China continues to be the leading producer and single leading consumer of IOPs. However, a number of issues are facing the industry, including increased manufacturing costs owing to rising steel and fuel costs and environmental costs. This has resulted in increasing Chinese IOP prices. Numerous mergers have taken place in the domestic industry (O'Driscoll, 2004).

IOP producers in Western Europe also have been dealing with several challenges, including relatively mature markets, large number of producers and traders, oversupply and low overall capacity utilization, and increased Asian competition, especially from China and India (Will, Schlag, and Kishi, 2004, p. 575.0003 N).

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TABLE 1  
SALIENT U.S. IRON OXIDE PIGMENTS STATISTICS<sup>1</sup>

		2000	2001	2002	2003	2004
Sold or used by producers:						
Crude pigments: <sup>2</sup>						
Quantity	metric tons	57,100	61,500	W	W	W
Value	thousands	\$4,470	\$3,460	\$1,070	W	W
Finished pigments: <sup>3</sup>						
Quantity	metric tons	154,000	135,000	115,000	90,000 <sup>e</sup>	85,000 <sup>e</sup>
Value	thousands	\$142,000	\$130,000	\$117,000	\$89,000 <sup>e</sup>	\$77,000 <sup>e</sup>
Exports:						
Quantity	metric tons	9,640	9,100	6,270	4,500	3,120
Value	thousands	\$17,200	\$16,800	\$12,100	\$11,000	\$7,380
Imports for consumption:						
Quantity	metric tons	91,300	89,900	132,000	140,000 <sup>r</sup>	170,000
Value	thousands	\$76,700	\$76,900	\$96,300	\$96,600 <sup>r</sup>	\$116,000

<sup>e</sup>Estimated. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Data are rounded to no more than three significant digits.

<sup>2</sup>Mined.

<sup>3</sup>Natural (mined) and synthetic.

TABLE 2

FINISHED IRON OXIDE PIGMENTS SOLD BY PROCESSORS IN THE UNITED STATES, BY KIND<sup>1</sup>

Kind	2003		2004	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Natural:				
Black, magnetite	W	W	W	W
Umbers:				
Burnt	W	W	W	W
Raw	2,610	\$4,320	W	W
Red, iron oxide <sup>2</sup>	W	W	W	W
Undistributed and other <sup>e, 3</sup>	49,900	16,200	52,000	\$20,000
Total <sup>e</sup>	52,500	20,500	52,000	20,000
Synthetic:				
Black, iron oxide	W	W	W	W
Brown, iron oxide	--	--	--	--
Red, iron oxide	W	W	W	W
Yellow, iron oxide	22,400	39,100	21,300	35,600
Mixtures of natural and synthetic, iron oxides	W	W	W	W
Total	37,100	68,900	32,300	57,700
Grand total <sup>e</sup>	90,000	89,000	85,000	77,000

<sup>e</sup>Estimated. W Withheld to avoid disclosing company proprietary data; included with "Natural, undistributed and other" or "Synthetic, total." -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes pyrite cinder.

<sup>3</sup>Includes brown, burnt sienna, ocher, raw sienna, and data indicated by symbol W.

TABLE 3  
PRODUCERS OF IRON OXIDE PIGMENTS AND REGENERATOR IRON OXIDES IN THE UNITED STATES IN 2004

Producers	Plant location
<b>Finished pigments:</b>	
Alabama Pigments Co.	Green Pond, AL.
Lanxess AG	New Martinsville, WV.
Dynamic Color Solutions, Inc.	Milwaukee, WI.
Elementis Pigments Inc.	East St. Louis, IL; Easton, PA.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
Prince Manufacturing Co., Inc.	Quincy, IL; Bowmanstown, PA.
Rockwood Pigments Inc.	Beltsville, MD; St. Louis, MO.
Solomon Grind-Chem Services Inc.	Springfield, IL.
<b>Crude pigments:</b>	
Alabama Pigments Co.	Green Pond, AL.
Cleveland-Cliffs Iron Co., Mather Mine and Pioneer plant <sup>1</sup>	Negaunee, MI.
Hoover Color Corp.	Hiwassee, VA.
New Riverside Ochre Co., Inc.	Cartersville, GA.
<b>Regenerator iron oxides:</b>	
Bailey-PVS Oxides, L.L.C.	Decatur, AL; Fairfield, AL; Delta, OH.
International Steel Services, Inc.	Allenport, PA.
Weirton Steel Corp.	Weirton, WV.

<sup>1</sup>Closed July 31, 1979; shipping from stockpile.

TABLE 4  
ESTIMATED IRON OXIDE PIGMENT CONSUMPTION, BY END USE, AS A PERCENTAGE OF REPORTED SHIPMENTS

End use	All iron oxides		Natural iron oxides		Synthetic iron oxides	
	2003	2004	2003	2004	2003	2004
Coatings (industrial finishes and trade sales coatings—lacquers, paints, varnishes)	24	NA	16	NA	31 <sup>r</sup>	NA
Construction materials (cement, mortar, preformed concrete, roofing granules)	27	NA	W	NA	W	NA
Colorants for ceramics, glass, paper, plastics, rubber, textiles	12	NA	W	NA	W	NA
Foundry sands	W	NA	W	NA	--	NA
Industrial chemicals (such as catalysts)	10	NA	W	NA	W	NA
Other <sup>1</sup>	27	NA	84	NA	69 <sup>r</sup>	NA
Total	100	100	100	100	100	100

<sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

<sup>1</sup>Includes animal feed, cosmetics, ferrites, fertilizers, magnetic ink and toner, polishing agents, and data indicated by symbol W.

TABLE 5  
U.S. EXPORTS OF IRON OXIDES AND HYDROXIDES, BY COUNTRY<sup>1</sup>

Country	2003				2004			
	Pigment grade		Other grade		Pigment grade		Other grade	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Australia	124	\$230	222	\$366	17	\$70	308	\$595
Belgium	487	2,290	205	793	492	1,920	68	152
Brazil	18	108	238	305	16	90	232	254
Canada	9	12	11,300	10,700	39	50	11,100	12,600
China	86	146	21,200	2,950	219	275	43,600	8,080
Colombia	26	87	147	105	19	60	151	67
France	117	371	132	500	275	839	355	946
Germany	123	220	340	742	17	33	260	650
Hong Kong	544	1,320	1,100	1,650	84	109	1,500	2,040
India	223	431	308	94	170	349	320	311
Indonesia	--	--	214	286	46	37	115	207
Italy	5	19	1,080	783	--	--	1,910	1,240
Japan	12	60	1,340	1,030	52	80	710	500
Korea, Republic of	1,080	2,400	1,670	1,350	445	584	1,950	2,220
Malaysia	--	--	195	491	--	--	287	698
Mexico	603	293	1,440	1,720	437	492	1,690	1,610
Netherlands	2	7	634	1,170	8	20	643	1,180
Russia	536	1,350	241	408	296	668	220	411
Singapore	90	216	1,240	759	1	6	994	383
Taiwan	2	7	1,460	1,070	--	--	2,170	1,650
Thailand	23	43	816	451	18	29	918	334
United Kingdom	74	106	2,560	4,070	134	329	2,420	4,710
Other	313 <sup>r</sup>	1,330 <sup>r</sup>	671 <sup>r</sup>	938 <sup>r</sup>	335	1,350	769	1,050
Total	4,500	11,000	48,800	32,700	3,120	7,380	72,700	41,800

<sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 6  
U.S. IMPORTS FOR CONSUMPTION OF SELECTED IRON OXIDE PIGMENTS, BY TYPE<sup>1</sup>

Type	2003		2004		Principal sources, 2004 (metric tons)
	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)	
Natural:					
Earth colors <sup>3</sup>	3,410	\$1,420	3,270	\$1,410	Cyprus, 3,030; Germany, 83.
Micaceous	591	735	833	690	Austria, 307; Spain, 279.
Total	4,000	2,150	4,100	2,100	
Synthetic:					
Black	36,500	31,900	41,700	31,100	Germany, 16,900; China, 14,400; Italy, 5,190; Japan, 1,830; India, 1,800; Mexico, 902; Canada, 364.
Red	54,900	30,700	67,900	41,200	China, 43,600; Germany, 18,000; Canada, 896; Italy, 873; Sweden, 710; Hong Kong, 637; Belgium, 502; India, 303; Mexico, 274.
Yellow	41,600	27,500	52,600	36,700	China, 37,000; Germany, 8,290; Brazil, 2,390; Italy, 1,550; Mexico, 1,350; Colombia, 711; Hong Kong, 511.
Other <sup>4</sup>	2,960	4,370	3,330	4,950	China, 1,790; Germany, 540; Japan, 417; Canada, 400.
Total	136,000	94,500	166,000	114,000	
Grand total	140,000	96,600	170,000	116,000	

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Customs value.

<sup>3</sup>Includes those earth colors not elsewhere specified or included.

<sup>4</sup>Includes synthetic brown oxides, transparent oxides, and magnetic and precursor oxides.

Source: U.S. Census Bureau.

TABLE 7  
U.S. IMPORTS FOR CONSUMPTION OF IRON OXIDE AND IRON HYDROXIDE PIGMENTS, BY COUNTRY<sup>1</sup>

Country	Natural				Synthetic			
	2003		2004		2003		2004	
	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)	Quantity (metric tons)	Value <sup>2</sup> (thousands)
Austria	314	\$321	307	\$309	--	--	--	--
Belgium	--	--	9	12	1,160	\$791	533	\$437
Brazil	--	--	--	--	2,970	2,570	3,020	2,520
Canada	--	--	--	--	1,410	2,100	1,970	3,230
China	--	--	--	--	72,800	36,100	96,800	52,800
Colombia	--	--	--	--	1,070	1,290	1,190	1,330
Cyprus	3,360	1,350	3,030	1,230	491	190	20	10
France	38	24	54	32	44	337	246	818
Germany	38	38	197	239	35,600	23,200	43,700	29,600
Hong Kong	--	--	--	--	2,490	1,400	1,200	638
India	5	3	11	6	5,040	2,790	2,240	1,380
Italy	--	--	--	--	5,390	6,260	7,620	8,750
Japan	20	14	59	102	2,740	12,500	2,800	7,810
Mexico	--	--	--	--	2,610	2,280	2,540	2,200
Spain	20	7	279	87	301	136	418	202
Sweden	--	--	--	--	1,360	330	750	175
United Kingdom	23	155	--	--	255	1,880	274	1,840
Other	182	239	155	86	237 <sup>r</sup>	221 <sup>r</sup>	203	129
Total	4,000	5,150	4,100	2,100	136,000	94,500	166,000	114,000

<sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Customs value.

Source: U.S. Census Bureau.

TABLE 8  
NATURAL IRON OXIDE PIGMENTS: ESTIMATED WORLD PRODUCTION, BY COUNTRY<sup>1, 2</sup>

(Metric tons)

Country <sup>3</sup>	2000	2001	2002	2003	2004
Austria	6,000	5,000	5,000	5,000	4,000
Brazil	2,000	2,000	2,000	2,000	2,000
Chile	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	--
Cyprus, umber	12,300 <sup>r, 4</sup>	7,800 <sup>r, 4</sup>	8,200 <sup>r, 4</sup>	11,900 <sup>r, 4</sup>	12,000
France	1,500	1,000	1,000	1,000	1,000
Germany	400 <sup>r</sup>	400 <sup>r</sup>	419 <sup>r, 4</sup>	429 <sup>r, 4</sup>	430
India, ocher	336,000	355,000	360,000	365,000	360,000
Iran	13,500	1,000 <sup>4</sup>	2,300 <sup>4</sup>	2,300	2,500
Italy	500	500	500	500	500
Pakistan, ocher	4,747 <sup>4</sup>	4,800	4,500	4,500	4,500
Paraguay, ocher	300	300	300	300	300
South Africa	568 <sup>4</sup>	852 <sup>4</sup>	252 <sup>4</sup>	643 <sup>4</sup>	421 <sup>4</sup>
Spain, ocher	87,000 <sup>4</sup>	87,000	80,000 <sup>r</sup>	80,000	75,000
United States	57,100 <sup>4</sup>	61,500 <sup>4</sup>	W	W	W

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.

<sup>1</sup>Estimated data are rounded to no more than three significant digits.

<sup>2</sup>Table includes data available through June 4, 2005.

<sup>3</sup>In addition to the countries listed, a number of others undoubtedly produce iron oxide pigments, but output is not reported, and no basis is available for formulating estimates of output levels. Such countries include Azerbaijan, China, Kazakhstan, Russia, Turkey, and Ukraine. Unreported output is probably substantial.

<sup>4</sup>Reported figure.